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RELATION OF PREFERENTIAL MOTION AND OF THE SPECTRAL-CLASS AND MAGNITUDE VELOCITY PROGRESSIONS TO PROPER MOTION

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This investigation concerned the relation between the preferential motion or streaming of the stars as interpreted by the ellipsoidal theory, and the size of proper motion.

It is based upon the radial velocities of Campbell's L. O. Catalogs[1] and Adams' Mt. Wilson Catalog,[2] a total of some 1800 stars. The stars, after being cleared of the effect of solarmotion, were divided into two classes according to size of proper motion, the 'large' ones being 0.″10 per year and over, while the 'small' ones are less than 0.″10, and into three classes by magnitude. The stars of Campbell's catalogs were divided into two groups, those of magnitude 2.9 and brighter and those of 3.0 to the limit of his catalogs which contain few stars fainter than 5½ magnitude. Adams' stars, with but few exceptions, are between magnitudes 5.5 and 6.5, and were treated separately as a third group.

Following the method of Kapteyn and Adams,[3] the radial velocities, without respect to sign, of the stars within 50° of the vertices of the ellipsoid were combined to represent the major axis of the ellipsoid which is designated by ρ_2. In a similar way those between 60° and 90° of the vertices were combined to represent the minor axis ρ_1.

The prolateness obtained for the stars of small μ of class F in Campbell's stars of 3.0 and fainter was 1.91. An examination showed that the average value of μ for these stars was considerably higher than for the other classes with small μ. The experiment was tried of limiting the proper motions of this group to 0.″05 which reduced the prolateness to 1.17. None of the other groups were so restricted in the matter of size of proper motion. The results for the different spectral classes are given in table 1 where the numbers of stars in the groups are in parentheses.

TABLE 1

PROLATENESS FROM RADIAL VELOCITIES

ρ_2/ρ_1

SPECTRAL CLASS	CAMPBELL'S L. O CATALOGS				ADAMS' MT. WILSON CATALOG	
	2.9 and brighter		3.0 and fainter			
	Small μ	Large μ	Small μ	Large μ	Small μ	Large μ
B	(30) 1.81		(113) 0.96		(81) 0.82	
A			(127) 1.18	(31) 1.79	(110) 1.23	(9) 1.88
F			(38) 1.17	(126) 1.63	(18) 1.33	(11) 2.00
G			(81) 1.31	(41) 1.54	(55) 1.64	(29) 2.88
K			(226) 1.09	(124) 1.42		
M			(52) 1.19	(13) 1.96		
K, M	(20) 1.23	(18) 0.87			(84) 1.17	(31) 1.19
A, F, G	(18) 4.56	(25) 1.50				

With the exception of the K and M stars of Adams' catalog and those of 2.9 and brighter of the same classes in Campbell's catalogs, a consistently smaller prolateness is shown for the small than for the large proper motions. These exceptions may be only coincidences, but they require further investigation.

The underlying idea in this investigation was that the nearer stars (those of large μ and also the very bright stars) might be subject to different preferential motions from the more distant stars. This was indicated by anomalies in the position of the apex of solar motion yielded by 110 of the stars of magnitude 2.9 and brighter, and in the positions yielded by the different sizes of proper motion. It is to be noted that the 30 bright B stars show a large prolateness and are quite consistent for so small a group—half of the velocities in the regions of the vertices of the ellipsoid are larger than any in the regions at right angles to the axis. The large velocities are found in the region of both vertices. The indications that the very distant stars are not subject to preference of motion for the ellipsoidal axis furnishes a satisfactory explanation of the peculiar behavior of the class B stars.

A dissymmetry has been observed in the velocities of the A, F, and G stars of small μ north and south of the ellipsoidal axis which produces the effect of a considerable prolateness. It is in the nature of smaller average radial velocities for the northern stars than for other parts of the sky. If determinations of prolateness are confined to northern stars only, values are obtained from the stars both of Campbell's and Adams' catalogs which are nearly the same as those yielded by the generally accepted constants of the ellipsoidal theory.

Evidence has been encountered in this investigation that the increases of radial velocity with spectral class and with decrease of brightness which have been observed, are in reality, largely at least, manifestations of the greater velocities which occur in the stars of large proper motion. When classified with respect to the size of proper motion and relation to the ellipsoidal axis, omitting a very few apparently exceptional velocities, these progressions disappear almost completely as will be seen from tables 2 and 3.

TABLE 2

ACCORDING TO SPECIAL CLASS*

(Small μ)

	ADAMS' MT. WILSON CATALOG			CAMBELL'S L. O. CATALOGS			
				3.0 and fainter		2.9 and brighter	
	ρ_2	ρ_1	Mean ρ	ρ_2	ρ_1	ρ_2	ρ_1
	km.	*km.*	*km.*	*km.*	*km.*	*km.*	*km.*
B..........	(52) 8.6	(29) 10.5	8.2	(60) 7.9	(53) 8.2	(16) 8.9	(14) 5.3
A..........	(49) 9.7	(55) 8.1	8.5	(56) 10.5	(60) 9.8		(3) 4.2
F..........	(6) 10.8	(10) 7.3	9.7	(18) 12.2	(18) 9.2	(4) 12.3	(3) 6.4
G..........	(23) 10.6	(29) 7.8	8.1	(44) 11.4	(32) 8.2		(3) 2.7
K..........	(25) 11.6	(24) 8.1	9.7	(80) 12.5	(120) 10.8	(6) 8.8	(8) 6.2
M..........	(11) 10.0	(13) 11.9	8.8	(13) 12.4	(28) 11.0	(2) 6.1	(1) 1.5

* Rejecting a few velocities of 30 km. and over.

TABLE 3

ACCORDING TO BRIGHTNESS*

	SMALL μ		LARGE μ			
	ρ_2	ρ_1	ρ_2	ρ_2'	ρ_1	ρ_1'
	km.	*km.*	*km.*	*km.*	*km.*	*km.*
2.9 and brighter....	(34) 13.5	(34) 6.2	(13) 15.9	54.8	(26) 13.6	35.8
3 to 5½............	(297) 13.6	(317) 11.8	(96) 26.4	69.3	(212) 17.6	40.2
5½ to 6½...........	(179) 12.4	(169) 10.4	(31) 45.2	70.6	(49) 22.3	39.8

* Omitting two stars in each of the two groups of 2.9 and brighter large μ because of the excessive effect in such small groups of their proper motions. ρ_2' and ρ_1' have been reduced to proper motion unity to make them comparable in that respect.

The conclusion from this investigation that the phenomenon of preferential motion for the ellipsoidal axis is confined to the nearer stars, in connection with the relation between radial velocity and proper motion which has been found by Kapteyn and Adams[3] automatically leads to the inference that the velocities of the nearer stars are greater than for the distant stars. Such a condition is confirmed by the velocities of 41 stars whose parallaxes have been observed to be 0.″06 or over. Their average radial velocity is 26.9 km. (or 20.7 km. if we omit four stars with velocities of from 73 km. to 98 km.) whereas the average velocity of a large number of stars of similar magnitude and spectral class (including many stars of small μ) which are undoubtedly at a much greater average distance than the 41 stars, may be taken at 15 km. (or 10 km. if limited to small proper motion).

Conclusions.—1. The preference for motion in the direction of the ellipsoidal axis appears to be confined to the stars of larger proper motion and brighter than 3.0 magnitude in all of the spectral classes with the possible exception of K and M. The limit of proper motion below which little or no preference for the ellipsoidal axis is shown, appears to be about 0.″05.

2. The increase in prolateness in the stars of large proper motion can be traced chiefly to the direction of the ellipsoidal axis.

3. This relation to proper motion furnishes a satisfactory explanation of the peculiar behavior of the stars of class B.

4. The radial velocities of the nearer stars are larger than those of the more distant stars.

5. When classified according to size of proper motion, and a few large motions are excluded, there is no certain increase in the radial velocities of the different spectral classes.

6. When the radial velocities are classified according to size of proper motion, there is no certain change with magnitude.

The details of this investigation will be published in the *Astrophysical Journal.*

[1] *Berkeley, Lick Obs., Univ. Cal. Bull.*, **6**, 1911, (108); **7**, 1913, (20, 113).

[2] *Pasadena, Contrib. Mt. Wilson, Solar Obs.*, No. 105.

[3] These PROCEEDINGS, **1**, 1915, (14).

GROWTH OF ISOLATED SPOROPHYTES OF ANTHOCEROS

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In view of the speculations concerning the possible derivation of the ferns from Anthoceros-like forms, it seemed worth while to determine how far the sporophyte is capable of an independent existence when separated from the supporting gametophyte.